NavStar Control Box Installation and User Manual

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NavStar Geomatics
107 – 140 Commercial Drive
Kelowna, BC, Canada
V1X 7X6

+1 604-540-1100 | info@rstinstruments.com
Toll Free (USA & Canada): +1 (800) 665 5599
www.navstar.com

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REVISION HISTORY

Rev.	Revision History	Date	Prepared By	Approved By
A	Initial release	13 November 2024	SM	SG, HW

1 INTENDED AUDIENCE

This installation and user manual is for the personnel responsible for installing or using the NavStar Control Box.

2 ICONS AND CONVENTIONS USED IN THIS GUIDE

This guide uses the following icons to call attention to important information.

	**WARNING:** This icon appears when an operating procedure or practice, if not correctly followed, could result in personal injury or loss of life.
	**CAUTION**: This icon appears when an operating procedure or practice, if not strictly observed, could result in damage to or destruction of equipment.
	**NOTE**: This icon appears to highlight specific non-safety related information.

3 SAFETY

	**WARNING:** Always follow safety precautions and use proper personal protective equipment (PPE) including safety glasses and high-visibility clothing when working in the field with this equipment.

4 ABBREVIATIONS AND ACRONYMS

This section lists abbreviations and acronyms used in the document.

Abbreviation or acronym	Definition
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
LTE	Long-Term Evolution
Wi-Fi	Wireless Fidelity
A/C or AC	Alternating Current
D/C or DC	Direct Current
IP	Ingress Protection

5 INTRODUCTION

The NavStar Control Box is a highly versatile and adaptable device, engineered for a variety of applications. It functions as the core component within all NavStar systems, serving as the central hub that connects all devices to the GeoExplorer software.

The NavStar Control Box is crucial for facilitating data communication and managing telemetry options, acting as a gateway for diverse data types including positioning data, data from total stations and prisms, SAA interface data, and more. It supports an extensive array of sensors and configurations, ensuring efficient data transmission to the GeoExplorer software.

It offers the flexibility to be powered by either A/C or solar energy and connects to GeoExplorer network via Ethernet, Wi-Fi, or LTE.

Figure 1: Control Box Enclosure Image

5.1 TYPICAL NAVSTAR CONTROL BOX CONFIGURATIONS

NOTE: Please select the configuration of the NavStar Control Box that best meets the individual project's requirements.

Each configuration is highly customizable. For adding functionalities based on project requirements, or information on more configurations, please contact NavStar.

5.1.1 GNSS Base Station

A typical order utilizing the GNSS Base Station Control Box configuration would include one high precision GNSS unit (GPM300), along with several GPS-monitoring GMS rovers (GMS700/GMS800). This Control Box configuration is a gateway with the added functionality of being a GPS Base Station. RTK (real-time kinematic) GNSS monitoring technology is utilized to ensure precise and accurate positioning data.

NOTE: The GMS rovers are not included in the GNSS Base Station Control Box setup, but at least one is mandatory for the monitoring system. Typically, several more are used in conjunction with it.

The main components of the GNSS Base Station Control Box configuration are:

- FLP200

  The FLP200 acts as a gateway, facilitating communication and data transfer. It can receive transmissions from the GMS rovers and relay them to GeoExplorer, and broadcast data corrections from GeoExplorer to the GMS rovers. The communication method between the FLP200 and GMS rovers depends on their respective configurations:

  - If both the FLP200 and GMS rovers have terrestrial radios installed, they communicate directly via radio transmissions.
  - If the GMS rovers have LTE radios, the FLP200 and GMS rovers communicate indirectly through the cellular network.

Figure 2: FLP200 Unit

- GPM300

  The GPM300 functions as a high precision GPS base station, providing accurate positioning data.
  The GPM300 attaches to the side of the FLP200 and communicates solely through the back 'bus connector' (RS485), acting as the reference node in the system.

Figure 3: GPM300 Unit

- GNSS Antenna

  The GNSS antenna receives signals from GNSS satellites, which are essential for the base station's operation in providing precise positioning data.

Figure 4: GNSS Antenna Unit

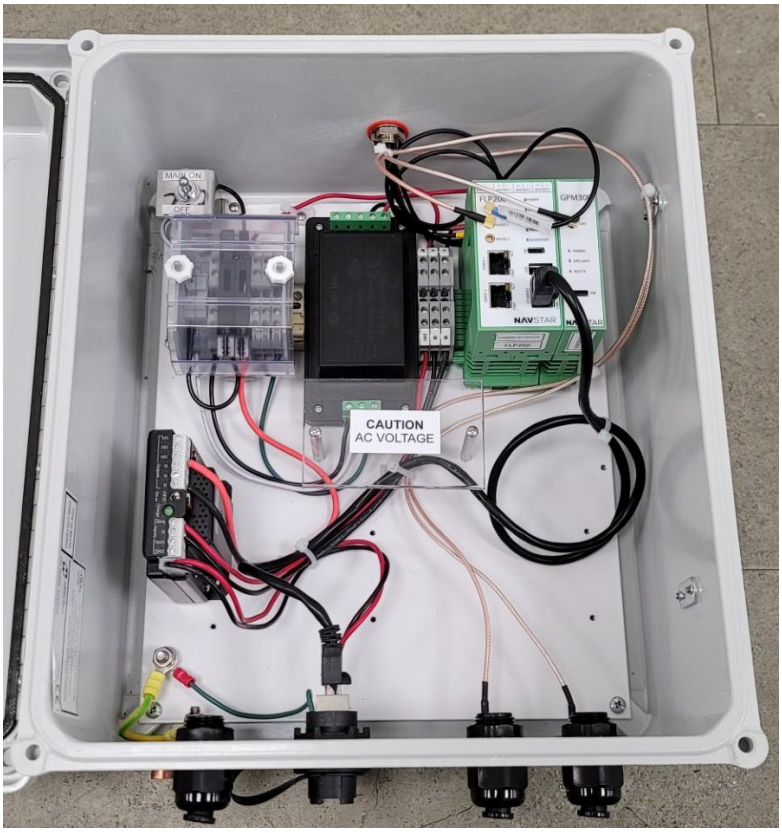
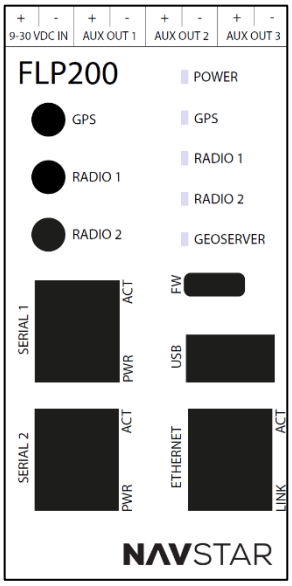


Figure 5: GNSS Base Station Configuration Control Box Internals

5.1.2 Gateway

The NavStar Control Box's Gateway configuration mainly uses the FLP200, essential for managing communication between connected devices and systems. It connects to GeoExplorer via Ethernet, Wi-Fi, or LTE, acting as a central hub for data handling and transfer.

This configuration can function independently or with other setups. For instance, a vibrating wire interface for a piezometer can link to the FLP200-based Gateway to send data to GeoExplorer. In a combined scenario, like with a GNSS Base Station for GPS monitoring, a second Gateway can enhance communication between distant Rovers by relaying data and corrections through GeoExplorer.



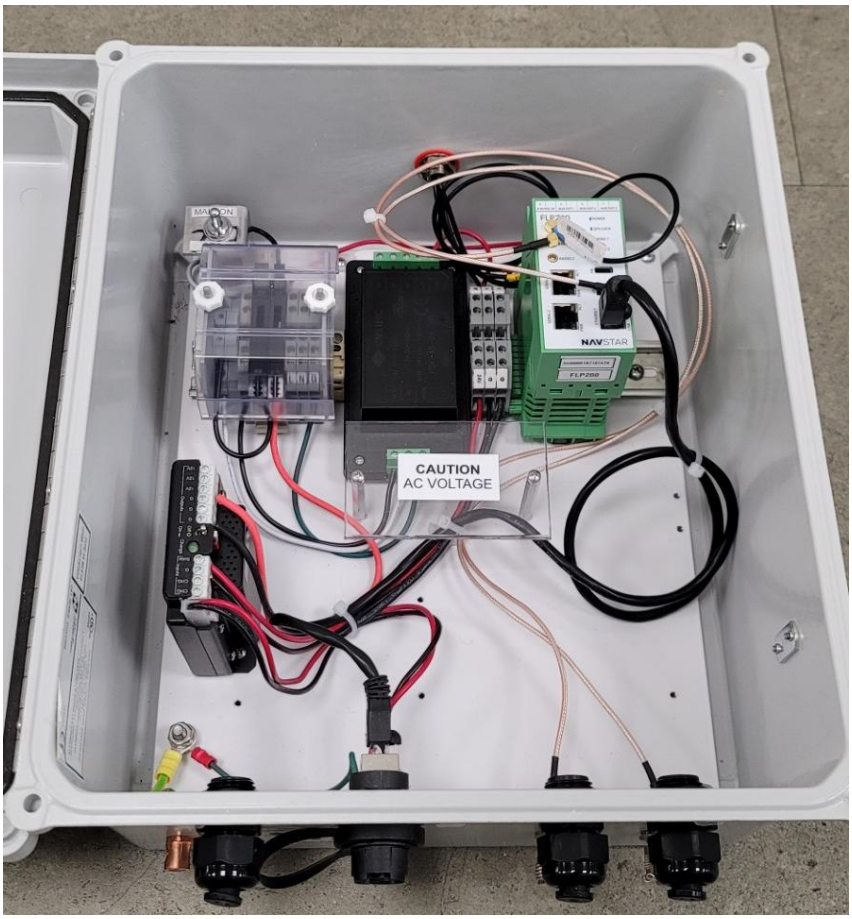
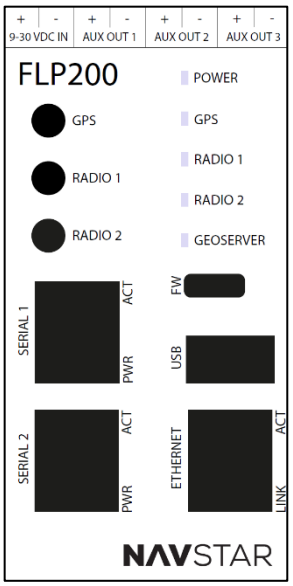


Figure 6: Gateway Configuration Control Box Internals

5.1.3 Total Station Control Box

The Total Station Control Box is configured with the FLP200 and utilizes RJ45 to DB9 cables for its serial 1 and serial 2 ports, as illustrated in the schematic diagram below. One serial port is dedicated to the Total Station, while the other is typically allocated for a weather station. The weather station, when used in conjunction with the Total Station, supplies essential data for atmospheric corrections.



This setup permits direct links with equipment, which is useful when devices are in close proximity and can be directly connected, such as in surveying tasks involving total stations and prisms.

The box operates effectively with these connections alone, eliminating the need for additional antennas, thus optimizing it for total station monitoring tasks.

The advancement of remotely controlling these measurements has prompted the development of systems where the total station, directed by GeoExplorer, adjusts to specific angles to measure distances to strategically placed prisms, facilitating the monitoring of landscape deformations.

Additionally, it can function as a gateway to other devices, such as a vibrating wire interface, and can simultaneously operate as a total station while managing data from a vibrating wire interface and serving as a GPS system base station.

The control box employs RJ45 connectors, typically linked with Ethernet, but uniquely adapted for the serial ports through a custom pinout, distinguishing the wiring for each port.

5.1.4 Repeater

The main component of the Repeater Control Box Configuration is the FLL400. This configuration is primarily used when monitoring devices are too far from the Gateway for proper data transmission. The FLL400 extends the transmission range, enhancing the reliability of data broadcast in challenging environments.

NOTE: The FLL400 repeater is typically used only in solar-powered systems. If hard-wired power is available, a gateway would likely be installed instead. Additionally, the repeater is exclusively used in systems with terrestrial radio communication; it is not employed in systems using LTE or Wi-Fi for data transmission.

Figure 7: FLL400 Unit

5.2 FEATURES

- Supports multiple communication and telemetry options
- Available in solar and A/C power options
- IP65 rated for water-ingress and dust protection
- Highly versatile and adaptable to changing project requirements
- Simplifies data collection and transmission to GeoExplorer
- Ensures reliable operation in diverse environmental conditions
- Facilitates easy troubleshooting and maintenance

5.3 APPLICATIONS

Some applications of the NavStar Control Box include:

- GNSS Base Station for GPS monitoring
- Gateway for device and system communication management
- Total Station Control Box for precise positioning and data collection
- Repeater to extend the transmission range and enhance data reliability in challenging environments

6 INSTALLATION GUIDELINES

NOTE: Specific installation instructions will depend on the individual project requirements and site conditions.

Please consult the site engineer or contact NavStar support for further instructions.

6.1 PRE-INSTALLATION CONNECTIVITY CHECK

Before installation, verify the Control Box system's functionality by checking power and communication through GeoExplorer. This includes assessing battery voltage and signal levels.

6.2 INSTALLATION CONSIDERATIONS

6.2.1 Unobstructed Sky View for the Base Station

To accurately transmit data, the Base Sation needs to have clear views of the sky, free of obstructions of any kind above 15 degrees from the horizon.

This includes power poles, trees, buildings, rock faces, and other similar obstructions.

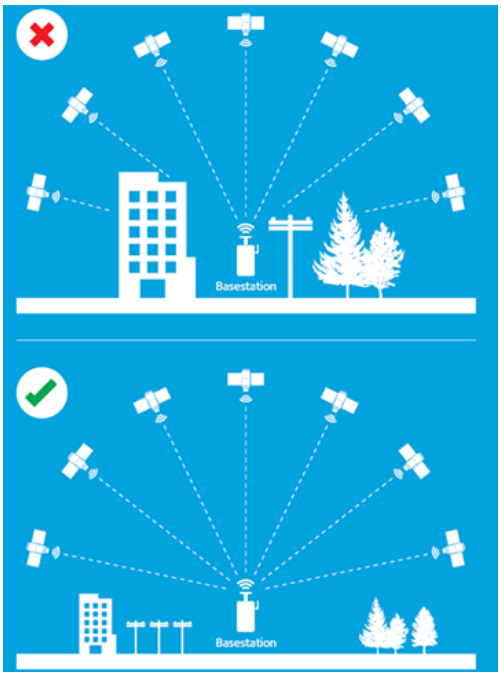


Figure 8: Non-Ideal and Ideal Base Station Sky View

6.2.2 GNSS Antenna (If Using) Installation Notes

The GNSS antenna used with the GNSS Base Station should be as high as possible and free from obstructions. The GNSS antenna should be secure without possibility of vibration or movement. A concrete pillar is the best solution.

Figure 9: GNSS Antenna Example Installation

6.2.3 Radio Antenna (If Using) Installation Notes

The LPWAN radio (region-specific frequency) antenna used with the GNSS Base Station should be as high as possible and free from obstructions. If possible, there would be a 'line of sight' view to each of the Rover units. The GNSS antenna should be secure without possibility of vibration or movement. A concrete pillar is the best solution.

6.2.4 Other Installation Considerations

1. The control box should be mounted securely and off the ground.

   The specific mounting structure is left to the client due to varying installation environments.

2. For its gateway functionality, the antenna should be installed as high as possible with a line of sight to the devices it communicates with.

3. It is essential to check the power and communication levels during installation using GeoExplorer. The control box should be connected to GeoExplorer first to visualize and troubleshoot data points.

6.3 INSTALLATION TOOLS AND COMPONENTS

Before installing the NavStar Control Box system, ensure the following components and tools are present:

- NavStar Control Box unit
- A/C power cable and source (if A/C powered)
- Solar panels with external batteries (if solar powered)
- GNSS antenna (if using the GNSS Base Station configuration)
- *Mounts and stands (if required)
- *Other installation tools and components

***NOTE**: Due to the highly individual nature of the installations, NavStar does not provide specific mounts or stands.

The customer is encouraged to source any additional tools and components required for their installation.

NOTE: For AC Base Station and Gateway configurations, please refer to Appendix A for visual instructions on connecting an AC wire to the Control Box. This does not apply to solar versions.

6.4 EXAMPLE INSTALLATION IMAGES

NOTE: The specifics of the installation can vary depending on project requirements and site conditions.

It is recommended to consult with the site engineer for specific details or contact NavStar for more information.

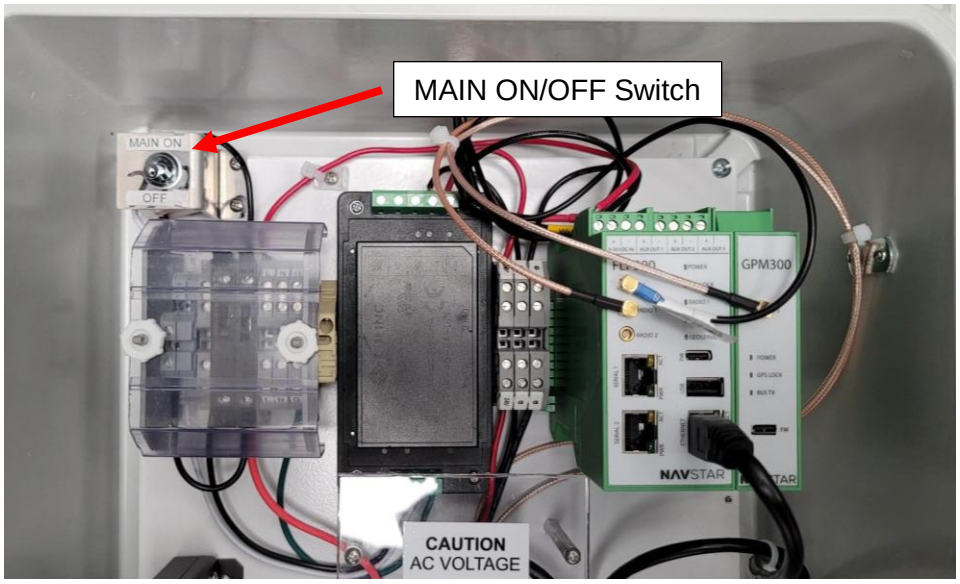
Example photos of typical installations are provided below for general guidance.

Figure 10: Example of Gateway Control Box Configuration Field Installation

Figure 11: Example of GNSS Base Station Control Box Configuration Field Installation

7 POWERING ON THE CONTROL BOX

1. Ensure the Control Box is connected to a power source (A/C or solar).
2. Open the Control Box lid to access the internals.
3. Power ON the Control Box by simply flicking the power switch to the MAIN ON option. The power switch's location can be seen in the figure below:



4. Close the Control Box lid and secure properly.

8 SWITCHING ANTENNA BASED ON CONNECTIVITY OPTION SELECTED

The NavStar Control Box features a combined Wi-Fi, LTE, and GPS antenna with three separate cables for each connectivity option.

Steps to configure the antenna are based on the selected connectivity option:

- For Basic GPS Connectivity: The 'simple' GPS antenna cable, which mounts to the top of the control box, should always be plugged into the GPS connector on the FLP200 (or FLL400).
- For High Precision GPS (GNSS) Monitoring: The GPS (GNSS) antenna cable should be plugged into the GPM300 (connector labeled GPS).
- For LTE or Wi-Fi connectivity: Depending on which radio module is installed in the FLP200, plug either the LTE or Wi-Fi cable into the Radio 2 connector. Then, select the corresponding option (Radio 2) from the SERVER CONNECTION dropdown menu in the GeoExplorer window.

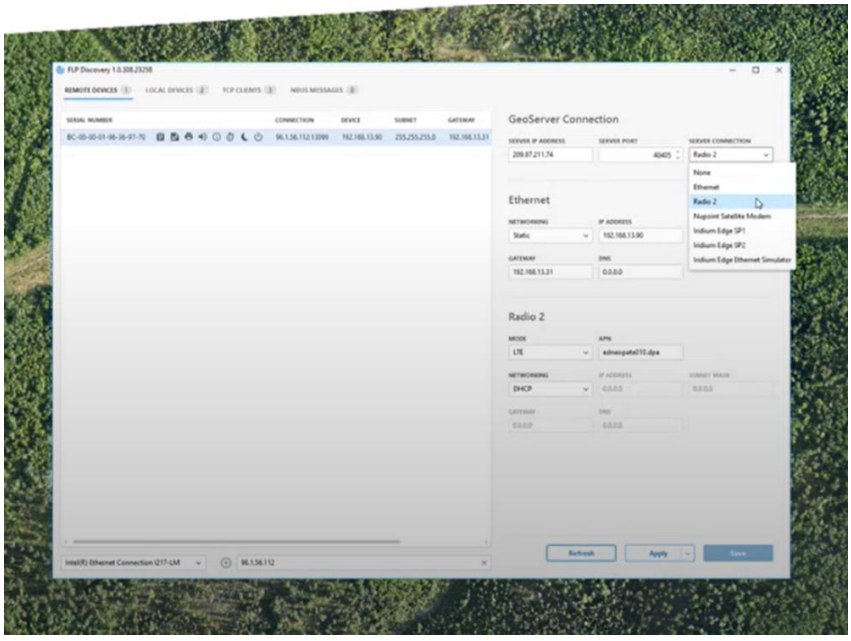


Figure 12: Configuring Connectivity in GeoExplorer

NOTE: If the Control Box is using terrestrial radio communication (e.g., a 900MHz radio module in North America), an external antenna should be plugged into the Radio 1 connector.

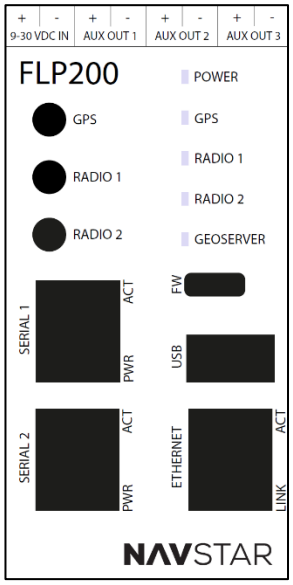
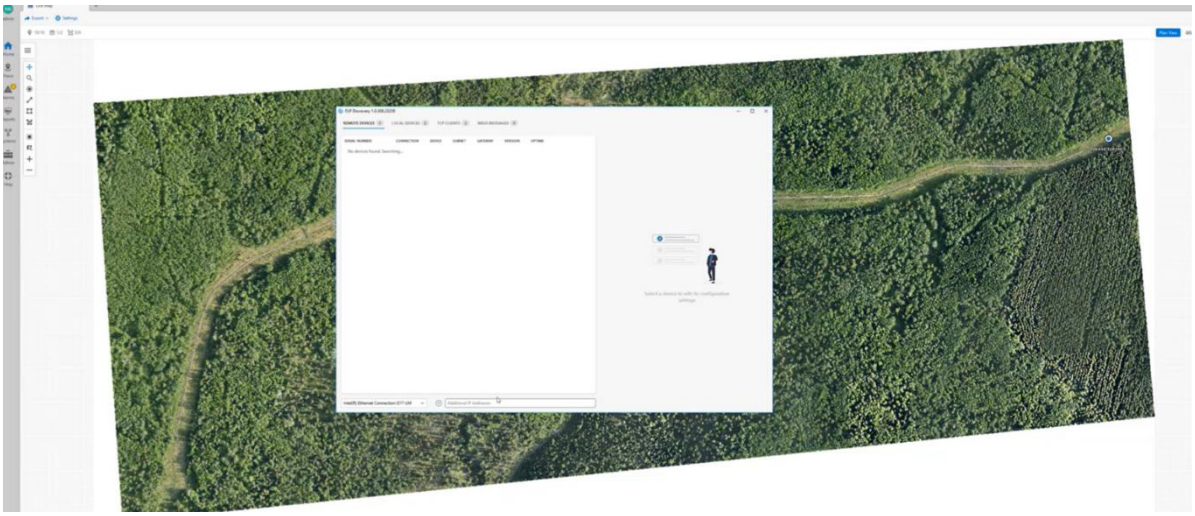


Figure 13: FLP200 Connections Schematic

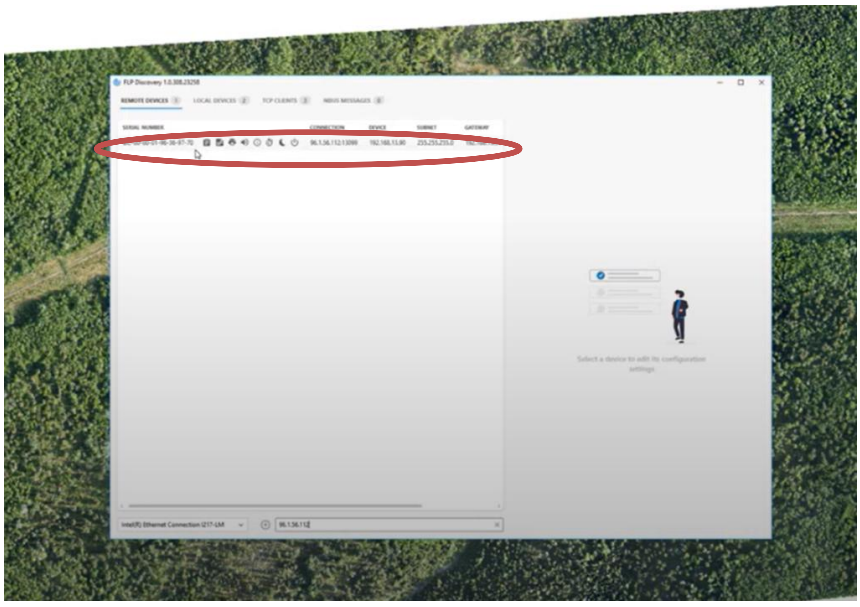
9 FLP200 CONFIGURATION USING FLP DISCOVERY APPLICATION

9.1 FLP200 CONFIGURATION VIA ETHERNET

1. Launch the FLP Discovery application. The following window appears.



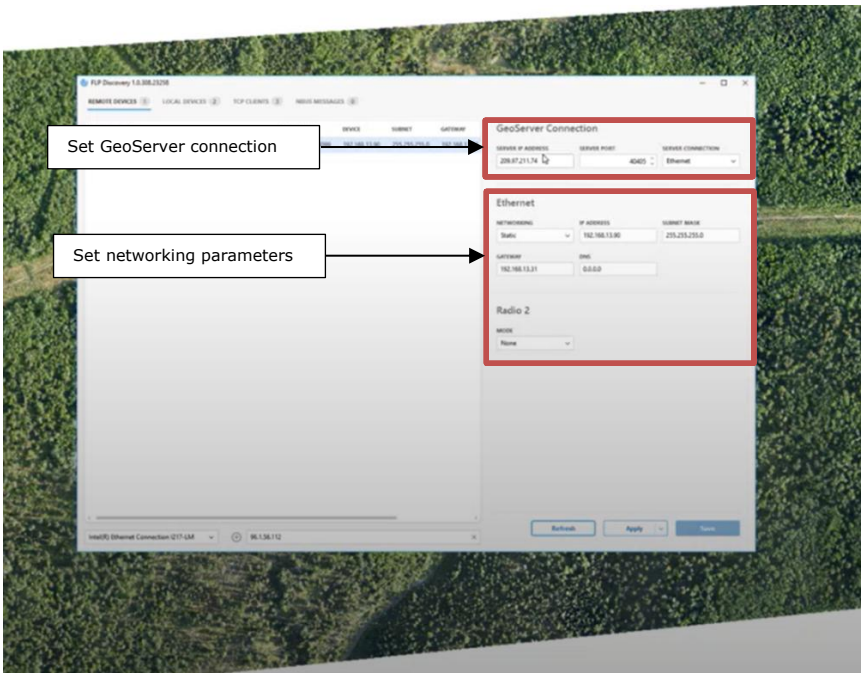
2. Connect a laptop with an Ethernet cable to the Ethernet port on the FLP200 in the Control Box. The device will then pop up in the FLP Discovery window under the REMOTE DEVICES tab.



3. Clicking on the device's serial number will display the GeoServer Connection and Utilities option.

   Set GeoServer Connection: enter the specific Server IP and Port for the user's GeoExplorer project. The default SERVER CONNECTION selection is Ethernet, which can be changed to Radio 2 for Wi-Fi or LTE connectivity.

   Set Networking Parameters: the top half of this box is for setting DHCP or a static IP address. The bottom half is for configuring LTE or Wi-Fi settings if Radio 2 is selected as the connection method.

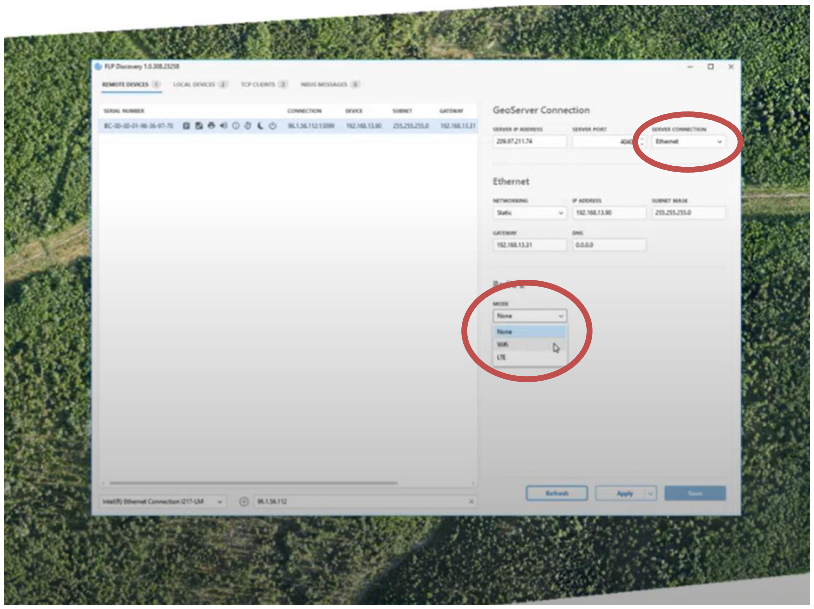


4. Once all parameters are verified, select Apply to finish the configuration.

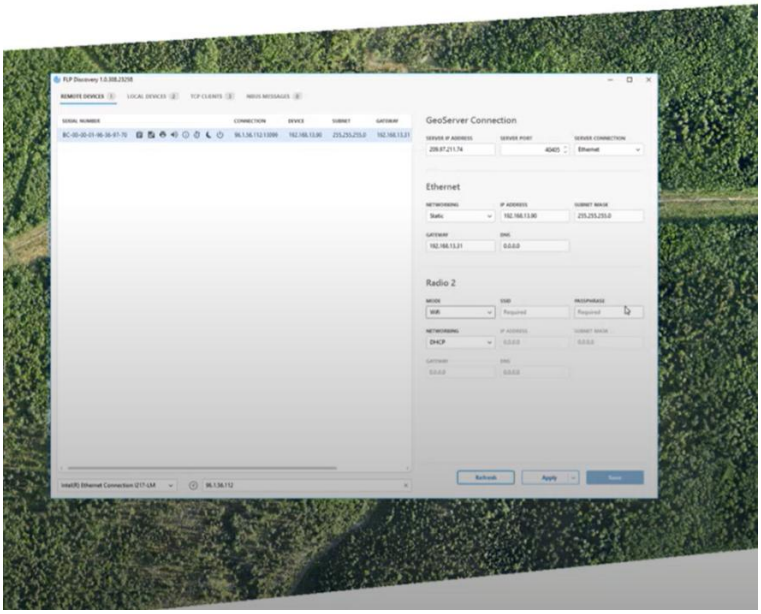
9.2 FLP200 CONFIGURATION VIA WI-FI

1. To connect via Wi-Fi, install a Wi-Fi module in the FLP and select Wi-Fi from the MODE dropdown menu.

   Also, click on the SERVER CONNECTION dropdown menu to select the Radio 2 option.



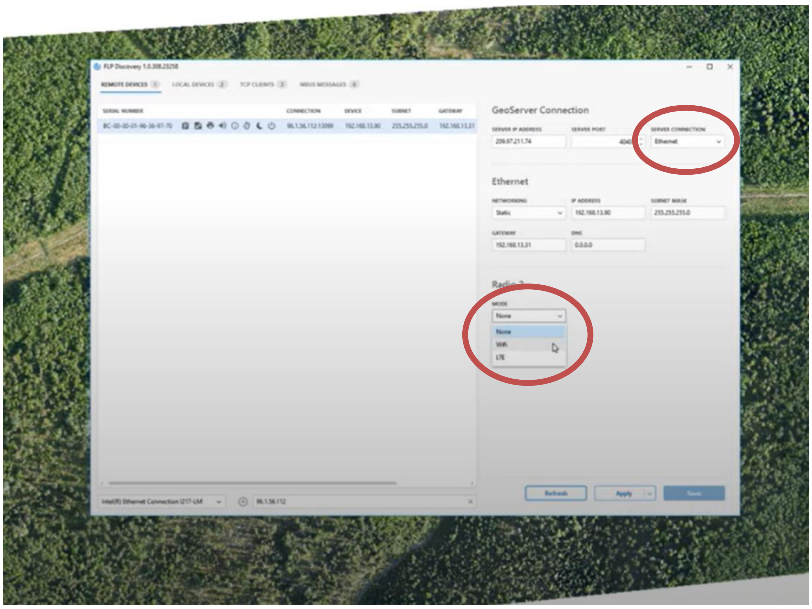
2. Enter the SSID, PASSPHRASE and NETWORKING (if applicable), and select Apply to finish configuration.



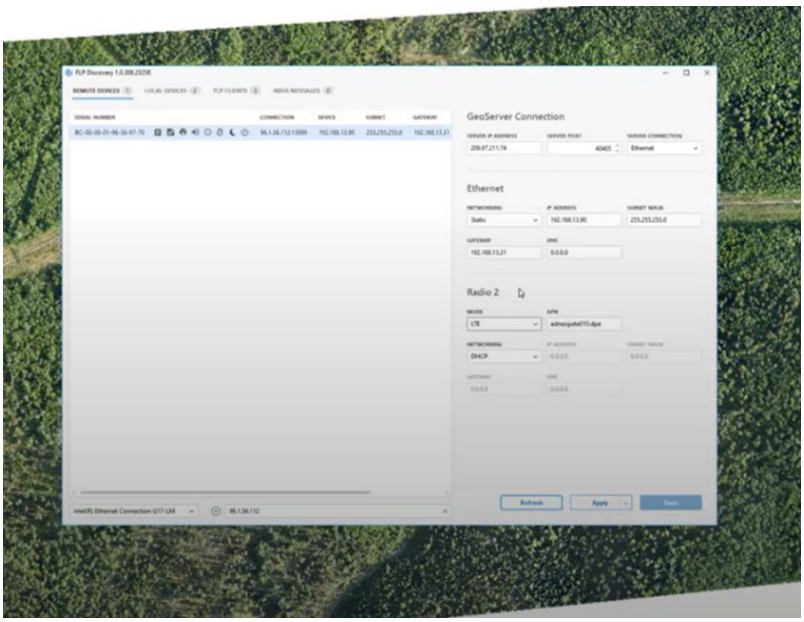
9.3 VIA LTE

1. To configure via LTE, install an LTE radio module in the FLP200, and select LTE from the MODE dropdown menu.

   Also, click on the SERVER CONNECTION dropdown menu to select the Radio 2 option.



2. Enter the APN code for the specific carrier depending on the SIM card that is installed in the radio module.



3. Select Apply to finish configuration.

9.4 CONFIGURING THE FLP200 OVER A LOCAL NETWORK

Besides connecting via Wi-Fi, LTE, or direct Ethernet, the FLP200 can also be accessed over a local network using the FLP Discovery Application. If the computer and the FLP200 are on the same subnet, the FLP device will automatically be displayed in the application, similar to a direct Ethernet connection.

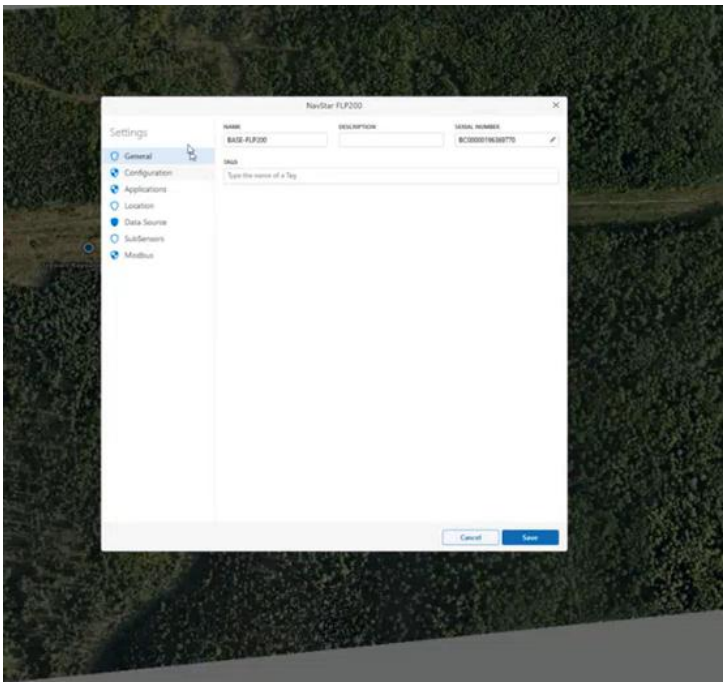
For discovery across different firewalls or networks, manual entry of the FLP200's IP address may be required. The FLP Discovery Application utilizes the default UDP port 13099 for device search. Ensuring this port is open and not blocked by firewalls is essential for successful device discovery.

10 DEVICE MANAGEMENT AND CONFIGURATION IN GEOEXPLORER

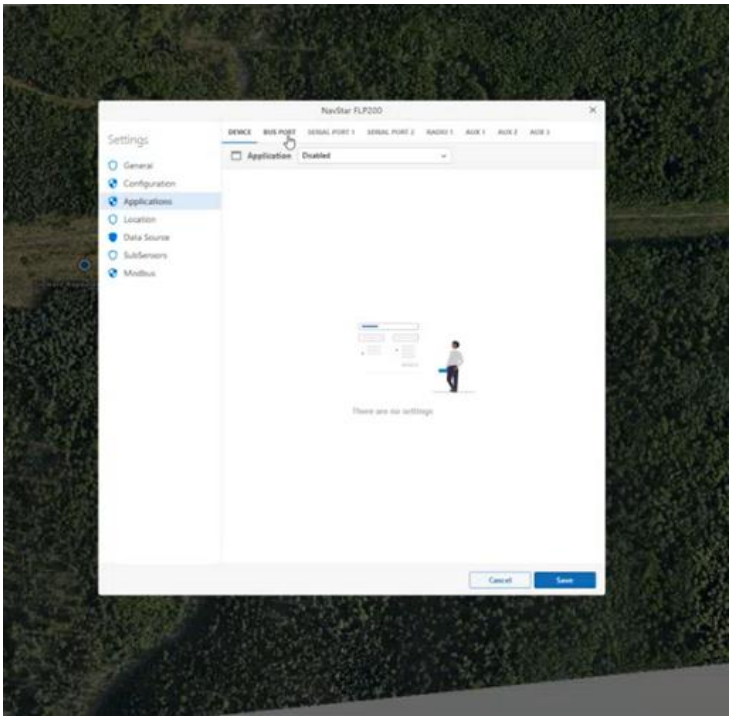
Once the FLP200 is active on the local network and the SERVER IP and SERVER PORT are configured in the FLP Discovery Application, the connected device will automatically appear in GeoExplorer. Initially, the device will be displayed in the 'default project' within GeoExplorer, particularly in installations where multiple projects are present.

The device can be found in the General window on the right-hand side of the main window, listed under All Sensors. Several diagnostic fields, such as voltage, current, and position, are displayed in this window for monitoring and management purposes.

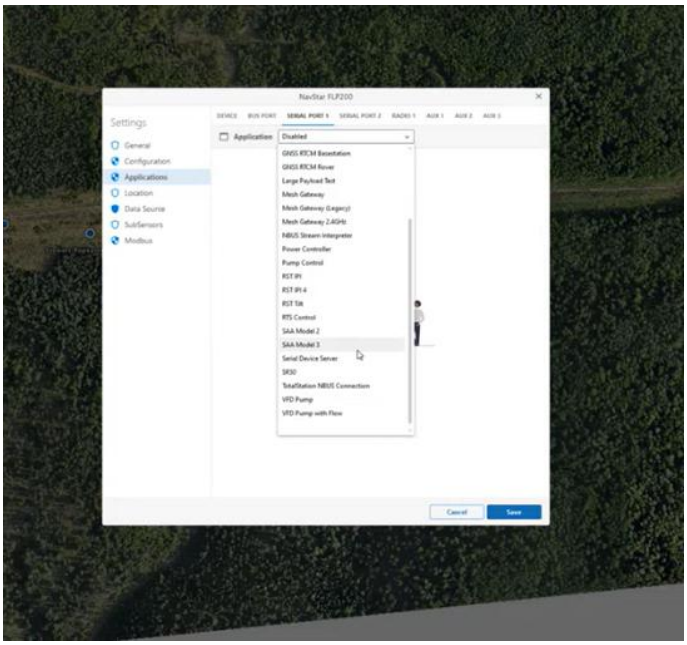
1. Click the Settings icon at the top of the device's diagnostics display to expand setting options.



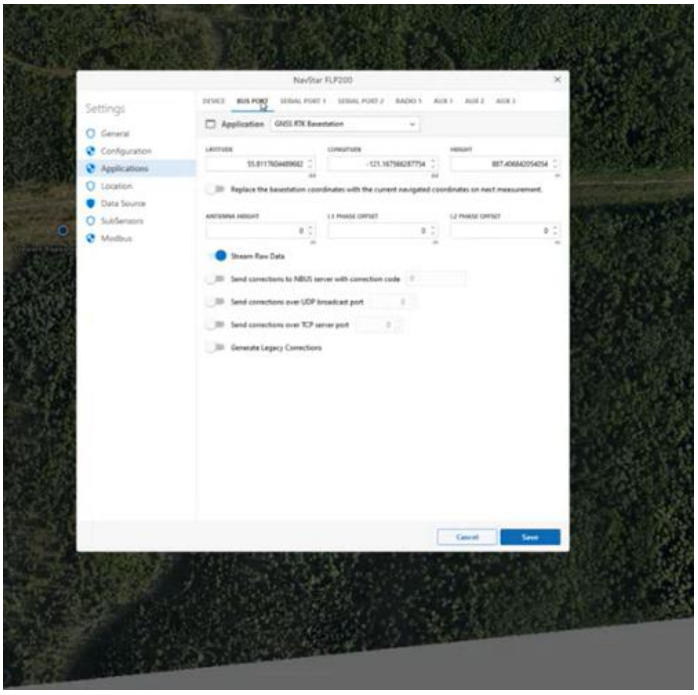
2. In the Applications menu, each connector for the FLP200 with its corresponding options can be viewed and configured, as required.



For example, while a more common connection for SERIAL PORT 1 would be a Total Station, the dropdown menu shows that other devices using the RS232 protocol (such as SAA or weather stations can be connected to the FLP200).



To configure the FLP200 as a GNSS Base Station when the GPM300 is attached, navigate to the BUS PORT menu. This is the method by which the FLP200 is connected to the GPM300.



11 POST-INSTALLATION CHECKS

- Communication Check: The communication link between the Control Box and GeoExplorer must be verified to confirm proper data transmission. For Ethernet connections (the default and most common method), signal testing is not typically required. For LTE or Wi-Fi connections, direct signal quality checks are not feasible due to the use of external networks. However, the FLP200's diagnostic messages in GeoExplorer can be monitored to assess connection status, power, and other environmental factors, ensuring proper data transmission.

- Diagnostic Messages: Set the control box to send diagnostic messages at regular intervals (e.g., every hour) to monitor its status. If a message is not received within the expected timeframe, it may indicate a communication failure.

- Visual Inspection: Conduct a visual inspection to ensure all components are securely mounted and there are no visible signs of damage or loose connections.

- Data Verification: Use GeoExplorer to verify that data from the control box is being received and logged correctly. This includes checking for any power failures or communication issues that might have occurred.

12 MAINTENANCE

- Alarm Setup for Communication Failures
  Implement alarms that triggers notifications in case of communication failures. This feature is crucial for prompt detection and resolution of issues that may disrupt system operations.

- Monitoring Solar Voltage (if the Control Box is solar-powered)
  Regularly review the input voltage data in the FLP200's diagnostic messages to observe the charging and discharging patterns. This monitoring is essential for diagnosing potential failures in the solar panels, which could impact the system's power supply.

13 TROUBLESHOOTING

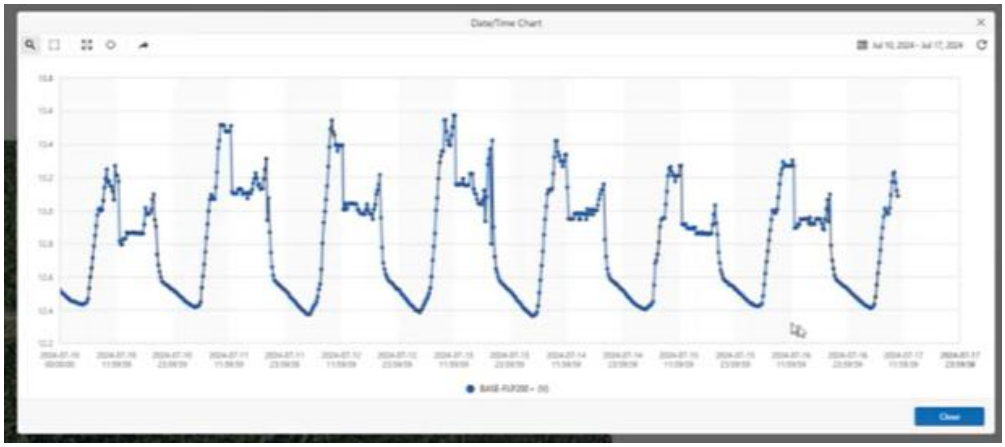
NOTE: The troubleshooting procedures mentioned here are for the most encountered issues. For additional support, contact NavStar Geomatics.

13.1 COMMUNICATION FAILURES

Configure the FLP 200 device to send diagnostic messages at regular intervals to monitor communication status. Set up an alarm to alert the user if communication fails, indicated by the absence of expected diagnostic messages.

13.2 POWER ISSUES

Monitor the solar voltage chart in GeoExplorer to ensure proper charging and discharging patterns. If the typical curve is absent, it may indicate a failure in the battery or solar panels.



14 PRODUCT SPECIFICATIONS

Item	Specification
Physical Specifications (Weight)	
5.8 kg to 6.8 kg (configuration dependent)	
External Battery Enclosure Weight	38 kg
Control Box General Specifications	
Enclosure Dimensions	400 mm x 352 mm x 197 mm
Enclosure Material	Fiberglass Reinforced Polyester
Connectors	TNC (F) for GNSS Antenna N (F) for Radio Antenna Ethernet RJ45 External Battery AC Power Solar Power Serial DB9 (Optional) Grounding Lug
Mounting	Pole and Wall
Temperature	Operating: -40°C to +60°C Storage: -40°C to +60°C
Environmental Protection	IP65
Power Supply Options	
AC / Lead Acid Battery	AC unit option 1: direct AC 12V 7Ah (no internal battery) AC unit option 2: 12V 100Ah external lead Acid Battery Solar units: charge control with 100Ah external battery
Solar	1 or 2 100W solar panels (depending on environmental conditions on project site) Please contact NavStar for more information. 12V 100Ahr external battery

Telemetry		
LPWAN Radio	868 MHz, 900 MHz	
Wi-Fi	802. 11	
LTE	Bands 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28 and 39	
LTE Carrier Approvals	AT&T (LTE-M), Verizon (LTE-M), Bell (LTE-M), Telus (LTE-M), PTCRB (LTE-M/NB-IoT)	
Certifications	RST Certification	
Sensors		
GNSS Channels	555	
GNSS Signals Received†	GPS L1 C/A, L1C, L2C, L2P, L5 GLONASS† L1 C/A, L2 C/A, L2P, L3, L5 Galileo† E1, E5 AltBOC, E5a, E5b, E6 BeiDou† B1I, B1C, B2I, B2a, B3I QZSS† L1 C/A, L1C, L2C, L5, L6 †*Optional, requires extra license*	
Environmental Sensors	Temperature, Input Voltage, Input Current, Runtime Metrics	
Typical GNSS Measurement Performance		
	Post Processing Mode	Real-Time Kinematic Mode
Horizontal Repeatability (24 hr average)	3mm*	8mm*
Vertical Repeatability (24 hr average)	5mm*	15mm*
**The repeatability and precision of GNSS measurements at a particular location and time are affected by the number and geometric distribution of satellites in the visible sky, the effect of multipathing, unit distance from Base Station, and other factors. The measurement performance stated above assumes a typical installation with favourable topography.*		

GNSS Antenna	
Signals Received	GPS L1 / L2 GLONASS L1 / L2 Galieo E1 Beidou B1
Dimensions	176 mm D x 55 mm H
Connector	TNC (F)
Mounting	5/8” Coarse Thread Mount
Phase Center Stability	< 2.0mm
FLP200	
Power	Nominal Voltage: 12V (DC) Input Voltage Range: 9-30V (DC) Power Consumption: 1.6-1.9W (approx.) Switched Power Output: 3 channels
Temperature	Operating: -40 to +65°C Storage: -45 to +80°C
Ports	Firmware Update: USB-C Serial IO: 2 x RS232 Ethernet: RJ45 Bus: Full-Duplex RS485
Size	99 × 52 × 99mm
Weight	248g
Housing	Polyamide, green, inflammability class VO (UL94), DIN-rail mountable
Supported Modules	SER100 (Serial Expansion) (High Precision GNSS) GPM300 (High Precision GNSS)
Other Features	Remote firmware updates available via GeoExplorer software Internal hardware power management Watchdog timer support Full GeoServer / GeoExplorer support
Radio	900MHz (North America, Brazil, Australia) 868MHz (Global)

GPM300	
Power	Bus-powered through the FLP200 Power consumption: 2.1W (approx.)
Temperature	Operating: -40°C to +65 °C Storage: -45°C to +80 °C
Ports	Firmware update: USB-C
Size	99 × 26 × 99mm
Weight	144 g
FLL400	
Power	Nominal Voltage: 12V (DC) Input Voltage Range: 9-30V (DC) Power Consumption: 1.5W (approx.)
Temperature	Operating: -40 to +65°C Storage: -45 to +80°C
Ports	Firmware Update: USB-C GPIO: 1 input Bus: Full-Duplex RS485
Size	99 mm × 26 mm × 99 mm
Weight	124g
Housing	Polyamide, green, inflammability class VO (UL94), DIN-rail mountable
Radio	900MHz (North America, Brazil, Australia) 868MHz (EU, Africa)

15 SERVICE, REPAIR AND CONTACT INFORMATION

This product does not contain any user-serviceable parts. Contact NavStar Geomatics for product services or repairs.

- For sales information: sales@rstinstruments.com
- For technical support: support@rstinstruments.com
- Website: https://navstar.com/
- Toll free: +1 (800) 665 5599

NavStar Office

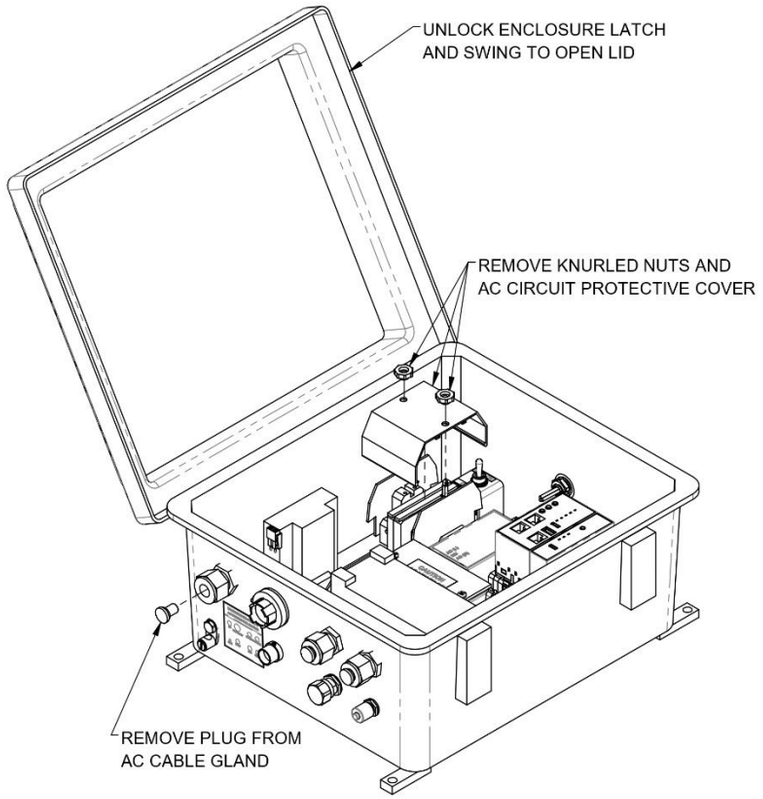
Address: 107 – 140 Commercial Drive, Kelowna, BC, Canada, V1X 7X6

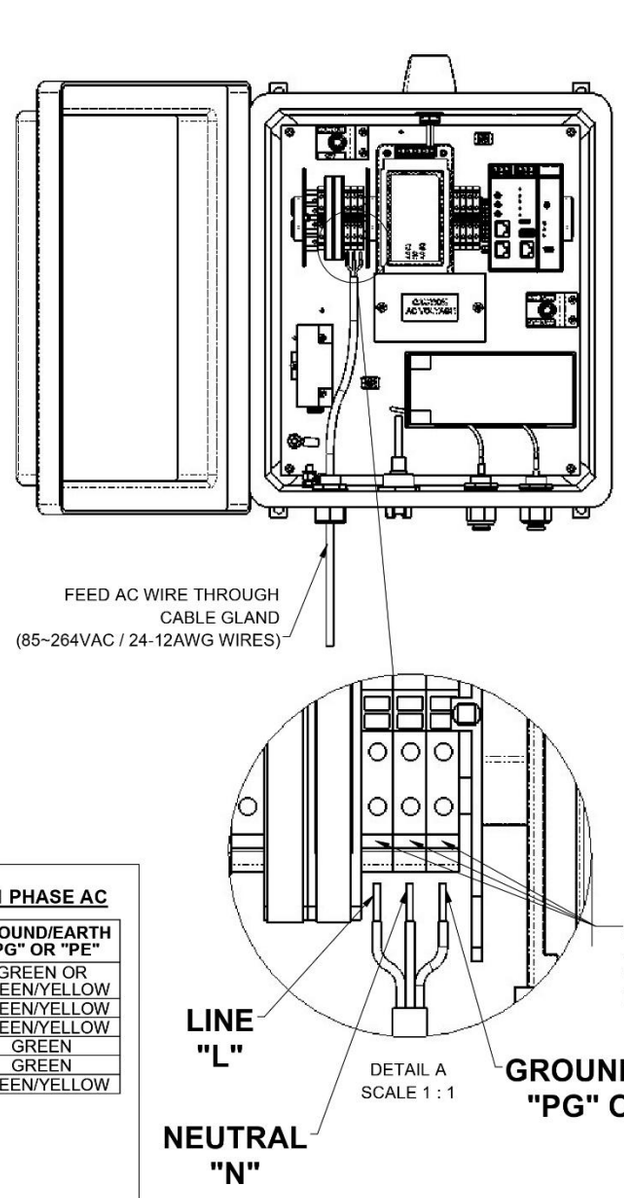
Telephone: +1 (604) 540 1100

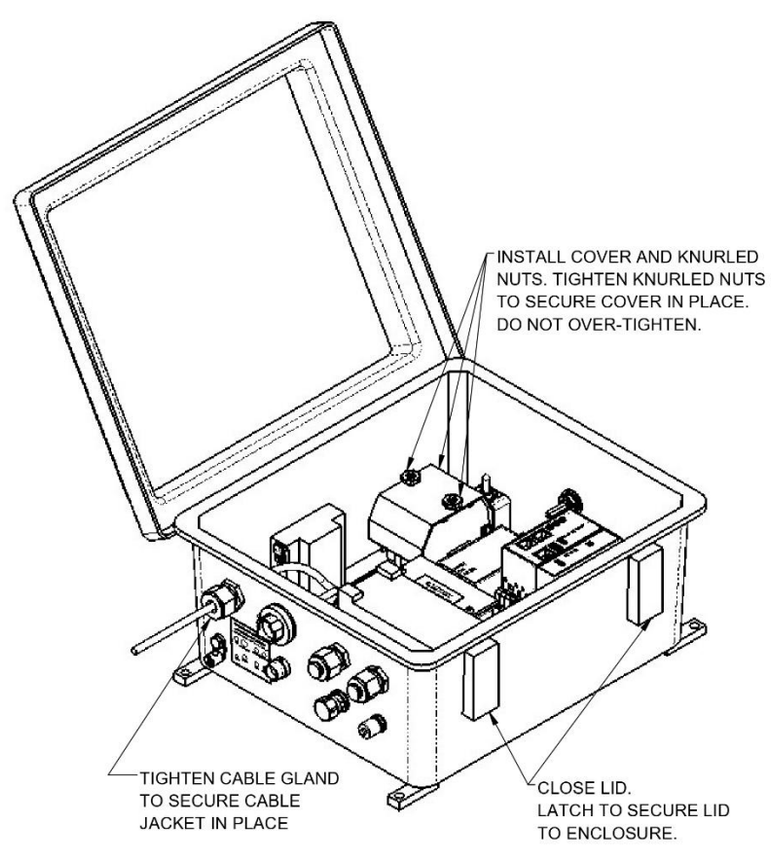
Fax: 604-540-1005

Business hours: 7:30 a.m. to 5:00 p.m. (PST) Monday to Friday, except holidays

APPENDIX A: CONNECTING AN AC WIRE TO THE CONTROL BOX BASE STATION OR GATEWAY

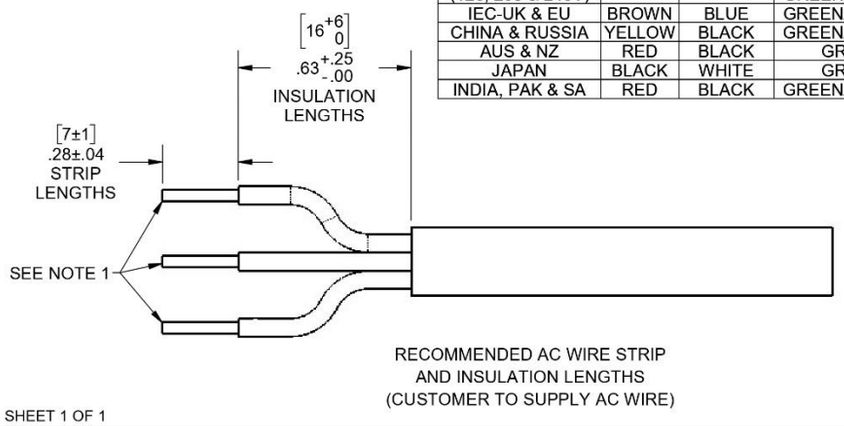






ELECTRICAL WIRING COLOR CODES - 1 PHASE AC

REGION	LINE "L"	NEUTRAL "N"	GROUND/EARTH "PG" OR "PE"
NEC-US/CANADA (120, 208 & 240V)	BLACK	WHITE	GREEN OR GREEN/YELLOW
IEC-UK & EU	BROWN	BLUE	GREEN/YELLOW
CHINA & RUSSIA	YELLOW	BLACK	GREEN/YELLOW
AUS & NZ	RED	BLACK	GREEN
JAPAN	BLACK	WHITE	GREEN
INDIA, PAK & SA	RED	BLACK	GREEN/YELLOW



RECOMMENDED AC WIRE STRIP
AND INSULATION LENGTHS
(CUSTOMER TO SUPPLY AC WIRE)

NOTES:
1. CRIMPING FERRULES ONTO LEADS BEFORE CONNECTING TO TERMINAL BLOCKS ARE RECOMMENDED BUT NOT REQUIRED. FERRULES TO BE SUPPLIED BY CUSTOMER.
2. FACTORY WIRES ARE NOT SHOWN FOR SIMPLICITY. DO NOT DISCONNECT FACTORY WIRES FROM ANY TERMINAL BLOCKS AND CONNECTIONS.

REV.	DESCRIPTION	DATE	DRAWN BY
A	INITIAL RELEASE	2024-06-28	HW

REVISIONS

EGBC STAMP
PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
A. A. BOBYREV
28270
Permit 1000386
2024-07-09

TOLERANCE
x.x ±.050"
x.xx ±.010"
x.xxx ±.005"
x° ±.5°
x.x° ±.10°

INSPECTION
XX DENOTES A DIMENSION FOR INSPECTION

USERS ARE RESPONSIBLE FOR ENSURING PRINTED COPIES ARE THE LATEST RELEASE REVISION

rst INSTRUMENTS

NAVSTAR BASE STATION / NAVSTAR GATEWAY

JUNCTION BOX CUSTOMER AC VOLTAGE WIRING

SCALE:	SIZE:	DWG #:	CHECKED BY:	APPROVED BY
1:48	B	ELS0176		AB
DATE:	PLM PART#:	REV:	DRAWN BY:	
2024-06-28	740-00019	A	HW	

SHEET 1 OF 1